Model 7002

Switch System

Quick Reference Guide

KEITHLEY

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Model 7002 Switch System
Quick Reference Guide

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Safety Precautions

The following safety precautions should be observed before using this product and any associated instrumentation. Although some instruments and accessories would normally be used with non-hazardous voltages, there are situations where hazardous conditions may be present.

This product is intended for use by qualified personnel who recognize shock hazards and are familiar with the safety precautions required to avoid possible injury. Read the operating information carefully before using the product.

The types of product users are:

Responsible body is the individual or group responsible for the use and maintenance of equipment, for ensuring that the equipment is operated within its specifications and operating limits, and for ensuring that operators are adequately trained.

Operators use the product for its intended function. They must be trained in electrical safety procedures and proper use of the instrument. They must be protected from electric shock and contact with hazardous live circuits.

Maintenance personnel perform routine procedures on the product to keep it operating, for example, setting the line voltage or replacing consumable materials. Maintenance procedures are described in the manual. The procedures explicitly state if the operator may perform them. Otherwise, they should be performed only by service personnel.

Service personnel are trained to work on live circuits, and perform safe installations and repairs of products. Only properly trained service personnel may perform installation and service procedures.

Exercise extreme caution when a shock hazard is present. Lethal voltage may be present on cable con-

nector jacks or test fixtures. The American National Standards Institute (ANSI) states that a shock hazard exists when voltage levels greater than 30V RMS, 42.4V peak, or 60VDC are present. **A good safety practice is to expect that hazardous voltage is present in any unknown circuit before measuring.**

Users of this product must be protected from electric shock at all times. The responsible body must ensure that users are prevented access and/or insulated from every connection point. In some cases, connections must be exposed to potential human contact. Product users in these circumstances must be trained to protect themselves from the risk of electric shock. If the circuit is capable of operating at or above 1000 volts, **no conductive part of the circuit may be exposed.**

As described in the International Electrotechnical Commission (IEC) Standard IEC 664, digital multimeter measuring circuits (e.g., Keithley Models 175A, 199, 2000, 2001, 2002, and 2010) are Installation Category II. All other instruments' signal terminals are Installation Category I and must not be connected to mains.

Do not connect switching cards directly to unlimited power circuits. They are intended to be used with impedance limited sources. NEVER connect switching cards directly to AC mains. When connecting sources to switching cards, install protective devices to limit fault current and voltage to the card.

Before operating an instrument, make sure the line cord is connected to a properly grounded power receptacle. Inspect the connecting cables, test leads, and jumpers for possible wear, cracks, or breaks before each use.

For maximum safety, do not touch the product, test cables, or any other instruments while power is applied to the circuit under test. ALWAYS remove power from the entire test system and discharge any capacitors before: connecting or disconnecting cables or jumpers, installing or removing switching cards, or making internal changes, such as installing or removing jumpers.

Do not touch any object that could provide a current path to the common side of the circuit under test or power line (earth) ground. Always make measurements with dry hands while standing on a dry, insulated surface capable of withstanding the voltage being measured.

The instrument and accessories must be used in accordance with its specifications and operating instructions or the safety of the equipment may be impaired.

Do not exceed the maximum signal levels of the instruments and accessories, as defined in the specifications and operating information, and as shown on the instrument or test fixture panels, or switching card.

When fuses are used in a product, replace with same type and rating for continued protection against fire hazard.

Chassis connections must only be used as shield connections for measuring circuits, NOT as safety earth ground connections.

If you are using a test fixture, keep the lid closed while power is applied to the device under test. Safe operation requires the use of a lid interlock.

If a screw is present, connect it to safety earth ground using the wire recommended in the user documentation.

The symbol on an instrument indicates that the user should refer to the operating instructions located in the manual.

The symbol on an instrument shows that it can source or measure 1000 volts or more, including the combined effect of normal and common mode voltages. Use standard safety precautions to avoid personal contact with these voltages.

The **WARNING** heading in a manual explains dangers that might result in personal injury or death. Always read the associated information very carefully before performing the indicated procedure.

The **CAUTION** heading in a manual explains hazards that could damage the instrument. Such damage may invalidate the warranty.

Instrumentation and accessories shall not be connected to humans.

Before performing any maintenance, disconnect the line cord and all test cables.

To maintain protection from electric shock and fire, replacement components in mains circuits, including the power transformer, test leads, and input jacks, must be purchased from Keithley Instruments. Standard fuses, with applicable national safety approvals, may be used if the rating and type are the same. Other components that are not safety related may be purchased from other suppliers as long as they are equivalent to the original component. (Note that selected parts should be purchased only through Keithley Instruments to maintain accuracy and functionality of the product.) If you are unsure about the applicability of a replacement component, call a Keithley Instruments office for information.

To clean an instrument, use a damp cloth or mild, water based cleaner. Clean the exterior of the instrument only. Do not apply cleaner directly to the instrument or allow liquids to enter or spill on the instrument. Products that consist of a circuit board with no case or chassis (e.g., data acquisition board for installation into a computer) should never require cleaning if handled according to instructions. If the board becomes contaminated and operation is affected, the board should be returned to the factory for proper cleaning/servicing.

Introduction

This quick reference guide includes summary information on front panel and IEEE-488 operation for the Model 7002 Switch System. For detailed information, consult the Model 7002 Instruction Manual.

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Operation Summary

Card type

On power-up, the Model 7002 detects Model 701X series cards that are installed and automatically configures itself for proper operation. Non-701X series card are not detected by the Model 7002. The model number of each non-701X series card must be assigned to the slot that it is installed in.

The TYPE selection in the CARD CONFIG MENU allows you to check and/or change the card type assignment for each slot:

Press: CARD CONFIGURATION
Select: TYPE
SLOT-#1 through SLOT-#10

Use the cursor keys (◀ and ▶) to check card type assignment for any slot. To change a slot assignment, select the slot, use the cursor keys to change the card type and press ENTER.

An empty slot can be used as a simulator by assigning it the model number 9990 (40-channel multiplexer) or 9991 (4 × 10 matrix).

Light pen option

Point and click programming using the light pen provides an easy and fast method to enter channels into the channel list and scan list. You simply point the pen at the appropriate channel LED and press the button on the barrel.

Control LEDs are also provided to perform other operations using the light pen. Most of these LEDs simply perform the same operations as their front panel key counterparts.

The light pen is operational when it is plugged into the front panel receptacle labeled LIGHT PEN.

Display modes

There are two basic display modes for the Model 7002; the relay status display mode and the list display mode. The VFD messages for the display modes are shown as follows:

Relay Status Display Mode	List Display Mode
RELAY STATUS	CHANNEL LIST DISPLAY or SCAN LIST DISPLAY

In addition to the basic display modes, you can also control the LED Graticule. Disbling the LED Graticule eliminates the dimly lit state for LEDs. LEDs are either off or brightly lit. See LED Graticule Control for more details.

Relay status display mode

In this display mode, the channel LEDs indicate the status (open or closed) of each channel. Table 1 summarizes the significance of the channel LEDs in this display mode.

Use the relay status display mode when closing/opening or scanning channels so that you can monitor the real-time state of each switch in your system.

List display mode

In this display mode, the channel LEDs indicate which channels are included in the selected list (channel list or scan list). Table 1 summarizes the significance of the channel LEDs in this display mode.

If you use this display mode when creating a list, be sure to return to the relay status display mode so that you can monitor the real-time state (on or off) of each available channel in your switch system.

Changing the display mode

The display mode can be changed through the MAIN MENU:

Press: MENU
Select: GENERAL
Select: DISPLAY
Select: SHOW-LIST
RELAY-STATUS CURRENT-LIST

RELAY STATUS selects the Relay Status Display Mode and CURRENT LIST selects the List Display Mode (see Menu Structures).

The display mode can also be changed by using the optional light pen. To toggle the display mode, simply click the SHOW LIST LED.

LED graticule control

LED Graticule control allows you to increase contrast between on and off LEDs by eliminating the dimly lit state for LEDs. With the LED Graticule disabled (off), LEDs will be either off or brightly lit. Table 1 explains the significance of the channel LEDs for the two graticule modes.

LED Graticule control is performed from the MAIN MENU as follows:

Press: MENU
Select: GENERAL
Select: DISPLAY
Select: GRATCULE-CONTROL
ON OFF

Select OFF to disable the LED Graticule or ON to enable it.

Table 1: Significance of channel LEDs

Display mode	LED graticule	Channel LEDs		
		Off	Dimly lit	Brightly lit
Relay status	On	Channel not available	Channel open	Channel closed
	Off	Channel not available or Channel open	—	Channel closed

Table 1: Significance of channel LEDs (cont.)

Display mode	LED graticule	Channel LEDs		
		Off	Dimly lit	Brightly lit
List	On	Channel not available	Channel not included in selected list	Channel included in selected list
	Off	Channel not available or channel not included in selected list	—	Channel included in selected list

Default configurations

From the front panel, default configurations are accessed from the MAIN MENU. Refer to Menu Structures for additional information on using the MAIN MENU.

RESET — The RESET default conditions are listed in Table 5. RESET is performed from the SAVESETUP selection in the MAIN MENU as follows:

Press: MENU
Select: SAVESETUP
Select: RESET

Factory Defaults — The instrument will return to the factory default conditions listed in Table 5 on power-up if the Power-On Default is set for Factory Default as follows:

Press: MENU
Select: SAVESETUP
Select: PWRON
Select: FACTORY-DEFAULT

User Saved Defaults — Up to ten setup configurations can be saved for future recall. The save and restore operations are performed from the SAVESETUP selection in the MAIN MENU as follows:

Press: MENU
Select: SAVESETUP
SAVE RESTORE

Use the SAVE selection to save the setup in a memory location (0-9). Use the RESTORE selection to return the instrument to the configuration saved at the specified memory location.

The instrument will return to user saved defaults on power-up if the Power-On Default is set for User Setup as follows:

Press: MENU
Select: SAVESETUP
Select: PWRON
Select: USER-SETUP

Use the USER SETUP selection to specify the memory location that contains the saved configuration.

Over the IEEE-488 bus, the following commands can be used to perform the same save and restore operations:

*SAV <NRf>	Save current setup configuration in memory (0 to 9).
*RCL <NRf>	Restore 7002 to setup configuration saved at specified memory location (0 to 9).
:SYSTem:POSetup SAVX	Program 7002 to power-on to the setup saved at memory location X (where X = 0 to 9).

Bus Defaults — Over the IEEE-488 bus, the following commands can be used to return the Model 7002 to default conditions:

*RST	Return 7002 to *RST defaults listed in Table 5.
:SYSTem:PRESet	Return 7002 to :SYSTem: PRESet defaults listed in Table 6.

The Model 7002 can be programmed to power-on to the *RST or :SYSTem:PRESet defaults by sending one the following commands over the bus:

:SYSTem:POSetup RST	Power-on to the *RST defaults.
:SYSTem:POSetup PRESet	Power-on to the :SYSTem: PRESet defaults.

Channel List and Scan List

A Channel List specifies the channels to be closed or opened, and a Scan List specifies the channels to be scanned.

Channel List Prompt	Scan List Prompt
SELECT CHANNELS	SCAN CHANNELS

Channel assignment formats

Matrix Card	Non-Matrix Card
S!R!C	S!C
S = Slot (1-10) R = Row (1-4) C = Column (1-10)	S = Slot (1-10) C = Channel (1-40)

Examples: 2!3!6 = Slot 2, Row 3, Column 6
9!38 = Slot 9, Channel 38

Creating a list

1. Select the desired list (Channel List or Scan List). Press the SCAN LIST key or click the SCAN LIST LED to toggle from one list to the other.
2. Enter channels into selected list:
   A. Keypad Method — Use the number keys to enter the channel assignment. Press ENTER or ▶ to separate entries or terminate the list. Use the hyphen key (-) to specify a channel range (i.e. 1!1-1!10).
   B. Light Pen Method — Click the corresponding channel LED to enter the channel into the list. Use the hyphen LED (-) to specify a channel range (i.e. 1!1-1!10).

Edit Keys and LEDs:

Cursor (◀ and ▶) — Select a channel entry by positioning the cursor on it.

DELETE — Press (or click) to delete selected entry.

INSERT — Press (or click) INSERT to enable insert function, place cursor at desired location in list and enter channel(s). Press (or click) INSERT a second time to disable insert function.

BACKSPACE — Click this LED to move the cursor to the left and delete the channel entry.

HOME — Click this LED to move the cursor to the beginning of the list.

END — Click this LED to move the cursor to the end of the list.

IEEE-488 bus commands — Over the bus, the Channel List is included with the commands to open and close channels (see Closing and Opening Channels). The Scan List is created using the :SCAN <list> command. Examples:

:SCAN (@ 5!4, 5!6, 5!8)

Scan List = channels 4, 6 and 8 of Slot 5.

:SCAN (@ 1!1:1!40)

Scan List = channels 1 through 40 of Slot 1.

Closing and opening channels

CLOSE key or CLOSE LED — Use to close channels specified in the displayed (selected) Channel List.

OPEN key or OPEN LED — Use to open channels specified in the displayed (selected) Channel List.

OPEN ALL key or OPEN ALL LED — Use to open all channels.

IEEE-488 Bus Commands — Over the bus, the :CLOSe and :OPEN commands are used to control channels. Examples:

:CLOSe (@ 4!1, 4!5)	Close channels 1 and 5 of Slot 4.
:OPEN (@ 4!1, 4!5)	Open channels 1 and 5 of Slot 4.
:OPEN ALL	Open all channels.

Scanning channels

Channels are scanned in the order that they are presented in the Scan List. To perform a scan, first program the controlling aspects of the scan (see Table 4), and then press (or click) STEP to take the Model 7002 out of the idle state (ARM indicator on).

Regardless of how the scan is configured, the STEP key (or LED) is always active allowing you to manually step through the scan. The scan can be terminated at any time by pressing (or clicking) OPEN ALL. All closed channels will open and the Model 7002 will return to the idle state (ARM indicator off).

IEEE-488 bus commands — Over the bus, a scan is configured using the Trigger Subsystem commands (see Table 16). The following command starts the scan by taking the Model 7002 out of the idle state:

:INITiate

The scan can be terminated by sending the following command:

:ABORt

All closed channels will open and the Model 7002 will return to the idle state.

Channel patterns (STORE and RECALL)

Up to 500 channel patterns can be stored in memory. A channel pattern is simply a pattern of open and closed channels.

There are two methods to store a channel pattern. One method is to store an actual open and closed pattern of relays (RELAY PATTERN) and the other method is to store the channel list (CURRENT LIST).

When a RELAY PATTERN is recalled, each channel will assume the state determined by the stored relay pattern. When a CURRENT LIST is recalled, the channels contained in the stored Channel List will close. Channels not included in the list will open.

Storing a Relay Pattern:

1. Close the desired channels.
2. Press STORE and select RELAY PATTERN.
3. Key in the memory location (1 to 500) and press ENTER.

Storing the Current List:

1. Create a Channel List.
2. Press STORE and select CURRENT LIST.
3. Key in the memory location (1 to 500) and press ENTER.

Recalling a channel pattern:

Press RECALL, key in the memory location of the stored channel pattern and press ENTER.

IEEE-488 bus commands — Over the bus, the following commands are used to store and recall channel patterns:

:MEMory:SAVE M<num>

Save Relay Pattern at specified memory location; <num> = 1 to 500.

:MEMory:SAVE:LIST <list>, M<num>

Save Current List at specified memory location; <list> = Channel List and <num> = 1 to 500.

:MEMory:RECall M<num>

Recall channel pattern from memory; <num> = 1 to 500.

Menu Structures

The desired menu is displayed by pressing the appropriate key; MENU, SCAN CONFIGURATION or CARD CONFIGURATION. Once in a menu structure, place the cursor (◀ and ▶ keys) on the desired selection and press ENTER. Use the keypad to enter parameters. Use the EXIT key to back out of the menu structure and disable the menu.

Table 2. MAIN MENU structure

Menu item	Description
SAVESETUP	Setup Menu:
SAVE	Save setup at a memory location (up to 10).
RESTORE	Return 7002 to setup stored at a memory location.
PWRON	Power-on Menu:
FACTORY DEFAULT	Power-on to factory default setup conditions.
USER SETUP	Power-on to setup stored at a memory location.
RESET	Return 7002 to original power-on setup.
GPIB	GPIB Setup Menu:
ADDRESS	Check/change IEEE-488 address.
STATUS	Display IEEE-488 status byte.
DIGITAL-I/O	Digital I/O Menu:
OUTPUT-STATUS	Check/change states of digital output channels.
OUTPUT-POLARITY	Check/change polarity of digital output port.
INPUT-STATUS	Read digital input channel.

Table 2. MAIN MENU structure (cont.)

Menu item	Description
TEST	Self-Test Menu:
BUILT-IN TESTS	Test Digital Board:
AUTO	Run all tests automatically.
MANUAL	Select tests to run.
DISPLAY TESTS	Test Display Board:
KEYS	Verify operation of front panel keys.
PATTERNS	Verify operation of VFD display.
LED BOARD	Verify operation of LED display.
CHAR SET	Display ASCII character set.
LANGUAGE	Choose 7002 Language:
ENGLISH	Display messages in English.
GERMAN	Display messages in German.
FRENCH	Display messages in French.
GENERAL	General Menu:
SERIAL #	Displays serial number, SCPI version, and software revision.
STATUS-MESSAGES	Enables/disables status message mode.
DISPLAY	Display Menu:
LED DISPLAY SETUP	LED Display Control:
SHOW-LIST	Change Display Mode.
GRATICULE-CONTROL	Disable/enable LED Graticule.
BREAK BEFORE MAKE	Enables/disables Break-Before-Make

Table 3. CARD CONFIG MENU structure

Menu item	Description
TYPE SLOT	Set Card Type: Assign model number to card in specified slot.
#-OF-POLES SLOT	Select # Of Poles: Select pole mode for card in specified slot.
CARD-PAIR	Enable or disable Card Pair.
DELAY SLOT	Set Delay For: Set delay for card in specified slot.
READ-I/O-CARD	Identify I/O Cards.

Table 4. CONFIGURE SCAN menu structure

Menu item	Description
CHAN-CONTROL	Configure Channel Layer:
CHANNEL-SPACING	Select channel spacing:
TIMER	Use a timer to select each channel in the scan.
EXTERNAL	Use an external trigger to select each channel.
GPIB	Use a bus trigger to select each channel.
MANUAL	Use STEP key to select each channel.
TRIGLINK	Use a Trigger Link trigger to select each channel.
ASYNCHRONOUS	Use separate lines for In/Out triggers.
SEMI-SYNCHRONOUS	Use same line for In/Out triggers.

Table 4. CONFIGURE SCAN menu structure (cont.)

Menu item	Description
CHAN-CONTROL	
CHANNEL-SPACING	
IMMEDIATE	Use to scan channels immediately.
HOLD	Use to hold up the scan in the channel layer.
NUMBER-OF-CHANS	Define number of channels to scan:
USE-SCANLIST-LENGTH	Count = number of channel entries in scan list.
CHAN-COUNT	User defined count:
INFINITE	Repeat channel scanning indefinitely.
ENTER-CHAN-COUNT	Count = user defined value (1 to 9999)
CONTROL	Select trigger control mode:
SOURCE	Enable the Source Bypass.
ACCEPTOR	Disable the Source Bypass.
SCAN-CONTROL	Configure Scan Layer:
SCAN-SPACING	Select scan spacing:
TIMER	Use the timer to control scan spacing.
EXTERNAL	Use external triggers to control scan spacing.
GPIB	Use bus triggers to control scan spacing.
MANUAL	Use STEP key to control scan spacing.
TRIGLINK	Use Trigger Link triggers to control scan spacing.
IMMEDIATE	Use to pass operation immediately into the channel layer.
HOLD	Use to hold up the scan in the scan layer.

Table 4. CONFIGURE SCAN menu structure (cont.)

Menu item	Description
SCAN-CONTROL	
NUMBER-OF-SCANS	Define number of scans to be performed:
INFINITE	Repeat scan indefinitely.
ENTER-SCAN-COUNT	Count = user defined value (1 to 9999).
CONTROL	Select trigger control mode:
SOURCE	Enable Source Bypass.
ACCEPTOR	Disable Source Bypass.
ARM-CONTROL	Configure Arm Layer:
ARM SPACING	Select arm spacing control:
MANUAL	Use STEP key to arm scanner.
IMMEDIATE	Use to arm scanner immediately.
GPIB	Use a bus trigger to arm scanner.
EXTERNAL	Use an external trigger to arm scanner.
TRIGLINK	Use a Trigger Link trigger to arm scanner.
HOLD	Use to hold up the scan in the arm layer.
ARM-COUNT	Define number of times to arm scanner:
INFINITE	Continuously re-arm scanner.
ENTER-ARM-COUNT	User defined count value (1 to 9999).
TRIGGER-CONTROL	Select trigger control mode:
SOURCE	Enable Source Bypass.
ACCEPTOR	Disable Source Bypass.
CHAN-RESTRICTIONS	Define channel restrictions:
SINGLE-CHAN	Enable/disable Single Channel Mode.
RESTRICTED-CHANNELS	Designate channels that cannot be closed.
INTERLOCK	Specify up to five sets of interlocked channels.

Default Conditions

Table 5. Factory default and RESET defaults

Item	Factory default	RESET
Display mode	Relay status	No change
Channel status	All open	All open
Channel list	Cleared	No change
Scan list	No change	No change
GPIB address	No change	No change
Digital I/O output level	High	High
Language	No change	No change
Status messages	Off	Off
# of poles	No change	No change
Card pair	Off	Off
Delay	0 sec	0 sec
Channel spacing	Manual (STEP key)	Manual (STEP key)
Number of channels	Scan list length	Scan list length
Channel trigger control	Source	Source
Scan spacing	Immediate	Immediate
Number of scans	Infinite	Infinite
Scan trigger control	Acceptor	Acceptor
Arm spacing	Immediate	Immediate
Arm count	1	1
Arm trigger control	Acceptor	Acceptor
Single channel	Off	Off
Restricted channels	No change	No change
Interlock	No change	No change
Break Before Make	On	On
LED Graticule	On	On

Note: "No change" indicates that currently set conditions are not affected.

*Table 6. *RST and :SYStem:PRESet Defaults*

Command name	*RST value	:SYSTem: PRESet value
:INITiate		
:CONTinuous	OFF	OFF
:ARM		
:SEQuence[1]		
:LAYer[1]		
:COUNt	1	1
:SOURce	IMMediate	IMMediate
:TCONfigure		
:DIRection	ACCeptor	ACCeptor
:ASYNchronous		
:ILINe	1	1
:OLINe	2	2
:LAYer2		
:COUNt	1	INFinite
:DELay	0	0
:SOURce	IMMediate	IMMediate
:TIMer	0.001	0.001
:TCONfigure		
:DIRection	ACCeptor	ACCeptor
:ASYNchronous		
:ILINe	1	1
:OLINe	2	2
:TRIGger		
:SEQuence1		
:COUNt	1	Scan list length
:AUTO	OFF	ON
:DELay	0	0
:SOURce	IMMediate	MANual
:TIMer	0.001	0.001
:TCONfigure		
:PROTocol	ASYNchronous	ASYNchronous
:DIRection	ACCeptor	SOURce
:ASYNchronous		
:ILINe	1	1
:OLINe	2	2
:SSYNchronous		
:LINE	1	1

*Table 6. *RST and :SYStem:PRESet Defaults (cont.)*

Command name	*RST value	:SYSTem: PRESet value
[:ROUTe]		
:CONFigure		
:BBMake	ON	ON
:SLOTX where X=1 to 10		
:STIMe	0	0
:CPAirX where X=1 to 5	OFF	OFF
:SCHannel	OFF	OFF
:DISPlay		
:SMESsage	OFF	OFF
:WINDow3		
:GRATicule	ON	ON

Error and Status Messages

Table 7. Error and status messages

Code number	Description
+551	"Incorrect software revision" (EE)
+550	"Forbidden channel error" (EE)
+530	"Slot 10 identification error" (EE)
+529	"Slot 9 identification error" (EE)
+528	"Slot 8 identification error" (EE)
+527	"Slot 7 identification error" (EE)
+526	"Slot 6 identification error" (EE)
+525	"Slot 5 identification error" (EE)
+524	"Slot 4 identification error" (EE)
+523	"Slot 3 identification error" (EE)
+522	"Slot 2 identification error" (EE)
+521	"Slot 1 identification error" (EE)
+510	"Saved state error" (EE)
+350	"Too many channels closed" (EE)
+174	"Re-entering the idle layer" (SE)
+173	"Waiting in arm layer 2" (SE)
+172	"Waiting in arm layer 1" (SE)
+171	"Waiting in trigger layer" (SE)
+161	"Program running" (SE)
+126	"Device calculating" (SE)
+125	"Device measuring" (SE)
+124	"Device sweeping" (SE)
+123	"Device ranging" (SE)
+122	"Device settling" (SE)
+121	"Device calibrating" (SE)
+101	"Operation Complete" (SE)
0	"No error" (SE)
-100	"Command Error" (EE)
-101	"Invalid Character" (EE)
-102	"Syntax Error" (EE)

Note: Messages associated with light pen operation are located in paragraph 4.5.3 of the Model 7002 Instruction Manual.

Table 7. Error and status messages (cont.)

Code number	Description
-103	"Invalid Separator" (EE)
-104	"Data Type Error" (EE)
-105	"GET not allowed" (EE)
-108	"Parameter not allowed" (EE)
-109	"Missing Parameter" (EE)
-110	"Command Header Error" (EE)
-111	"Command Header Separator Error" (EE)
-112	"Program mnemonic too long" (EE)
-113	"Undefined header" (EE)
-114	"Header suffix out of range" (EE)
-120	"Numeric data error" (EE)
-121	"Invalid character in number" (EE)
-123	"Exponent too large" (EE)
-124	"Too many digits in number" (EE)
-128	"Numeric data not allowed" (EE)
-140	"Character data error" (EE)
-141	"Invalid character data" (EE)
-144	"Character data too long" (EE)
-148	"Character data not allowed" (EE)
-150	"String data error" (EE)
-151	"Invalid string data" (EE)
-154	"String too long"
-158	"String data not allowed" (EE)
-160	"Block data error" (EE)
-161	"Invalid block data" (EE)
-168	"Block data not allowed" (EE)
-170	"Expression error" (EE)
-171	"Invalid expression" (EE)
-178	"Expression data not allowed" (EE)
-200	"Execution error" (EE)
-201	"Invalid while in local" (EE)
-202	"Settings lost due to rtl" (EE)
-210	"Trigger error" (EE)
-211	"Trigger ignored" (EE)
-212	"Arm ignored" (EE)

Table 7. Error and status messages (cont.)

Code number	Description
-213	"Init ignored" (EE)
-214	"Trigger deadlock" (EE)
-215	"Arm deadlock" (EE)
-220	"Parameter Error" (EE)
-221	"Settings conflict" (EE)
-222	"Parameter data out of range" (EE)
-223	"Too much data" (EE)
-224	"Illegal parameter value" (EE)
-241	"Hardware missing" (EE)
-260	"Expression Error" (EE)
-281	"Cannot create program" (EE)
-282	"Illegal program name" (EE)
-284	"Program currently running" (EE)
-285	"Program syntax error" (EE)
-330	"Self Test failed" (EE)
-350	"Queue overflow" (EE)
-410	"Query interrupted" (EE)
-420	"Query unterminated" (EE)
-430	"Query deadlocked" (EE)
-440	"Query unterminated after indefinite response" (EE)

EE = Error event
SE = Status event

Status Registers

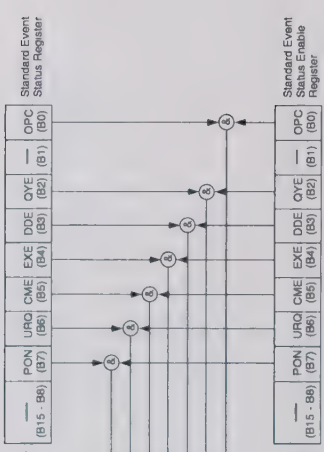

Figure 1. Standard event status

Figure 2. Operation event status

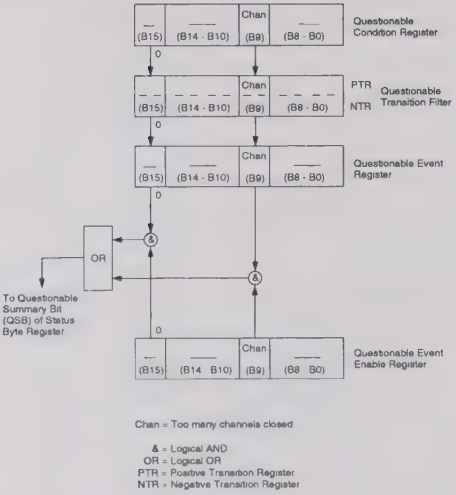

Figure 3. Questionable event status

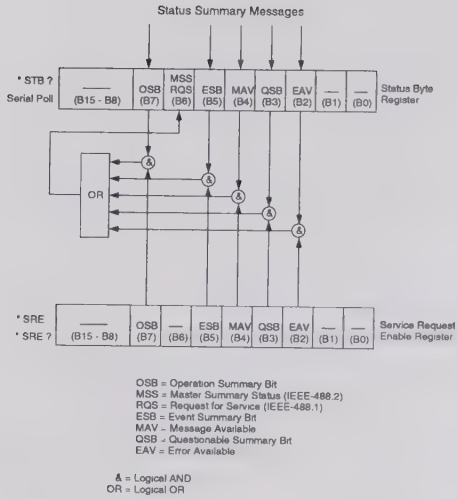

Figure 4. Status Byte and Service Request (SRQ)

IEEE-488.2 Common Commands

Table 8. Common commands

Mnemonic	Name	Description
*CLS	Clear status	Clears all event registers and Error Queue.
*ESE <NRf>	Event status enable command	Sets the contents of the Standard Event Status Enable Register.
*ESE?	Event status enable query	Request the programmed value of the Standard Event Status Enable Register.
*ESR?	Event status register query	Request the programmed value of the Standard Event Status Register and clear it.
*IDN?	Identification query	Request the manufacturer, model number, serial number, and firmware revision levels of the unit.
*OPC	Operation complete command	Sets the Operation Complete bit in the Standard Event Status Register after all pending commands have been executed.
*OPC?	Operation complete query	Places an ASCII "1" into the output queue when all pending selected device operations have been completed.
*OPT?	Option identification query	Request the assigned model number for all slots.

Table 8. Common commands (cont.)

Mnemonic	Name	Description
*RCL <NRf>	Recall command	Returns the Model 7002 to the setup configuration stored in the designated memory location.
*RST	Reset command	Returns the Model 7002 to the *RST default conditions.
*SAV <NRf>	Save command	Saves the current setup configuration to the designated memory location.
*SRE <NRf>	Service request enable command	Sets the contents of the Service Request Enable Register.
*SRE?	Service request enable query	The Model 7002 returns the value of the Service Request Enable Register.
*STB?	Read status byte query	Returns the value of the Status Byte Register.
*TRG	Trigger command	This command issues a bus trigger which has the same effect as group execute trigger (GET) command.
*TST?	Self-test query	When this query is sent, the Model 7002 will perform a checksum test on ROM and return the results.
*WAI	Wait-to-continue command	Wait until all previous commands are executed.

Note: At least one space is required between the command and the parameter

Notes:

1. Brackets ([ ]) are used to denote optional character sets. These optional characters do not have to be included in the program message. Do not use brackets ([ ]) in the program message.
2. Angle brackets (< >) are used to indicate parameter type. Do not use angle brackets (< >) in the program message.
3. Upper case characters indicate the short-form version for each command word.
4. At least one space is required between a command word and the parameter.

Table 9. :DISPlay command summary

Command	Description
:DISPlay	
[:WINDow[1]]	Path to locate message to top display.
:TEXT	Path to control user text messages.
:DATA <a>	Define ASCII message "a" using up to 20 characters.
:DATA?	Query text message.
:STATe <b>	Enable (1 or ON) or disable (0 or OFF) message mode.
:STATe?	Query text message mode (0 or 1).
:WINDow2	Path to locate message to bottom display.
:TEXT	Path to control user text messages.
:DATA <a>	Define ASCII message "a" using up to 32 characters.
:DATA?	Query text message.
:STATe <b>	Enable (1 or ON) or disable (0 or OFF) message mode.
:STATe?	Query text message mode (0 or 1).
:WINDow3	Path to control LED Graticule.
:GRATicule <b>	Enable (1 or ON) or disable (0 or OFF) the LED Graticule.
:SMESsage <b>	Enable (1 or ON) or disable (0 or OFF) status message mode.
:SMESsage?	Query status message mode (0 or 1).
:ENABle <b>	Turn on (1 or ON) or turn off (0 or OFF) the front panel display circuitry.
:ENABle?	Query state of the display (0 or 1).

Table 10. :OUTPut command summary

Command	Description
:OUTPut	
:TTL[1]	Path to set polarity of digital output line 1:
:LSENse <name>	Select polarity; active high (AHIGh) or active low (ALOW).
:LSENse?	Query polarity of line 1.
:TTL2	Path to set polarity of digital output line 2:
:LSENse <name>	Select polarity; active high (AHIGh) or active low (ALOW).
:LSENse?	Query polarity of line 2.
:TTL3	Path to set polarity of digital output line 3:
:LSENse <name>	Select polarity; active high (AHIGh) or active low (ALOW).
:LSENse?	Query polarity of line 3.
:TTL4	Path to set polarity of digital output line 4:
:LSENse <name>	Select polarity; active high (AHIGh) or active low (ALOW).
:LSENse?	Query polarity of line 4.

Table 11. ROUTe command summary

Command	Description
[:ROUTe]	
:CLOSe <list>	Close specified channels.
:STATe?	Query list of closed channels.
:CLOSe? <list>	Query state of specified channels (1 = closed, 0 = open).
:OPEN <list>|ALL	Open specified (or all) channels.
:OPEN? <list>	Query state of specified channels (1 = open, 0 = closed).
:SCAN <list>	Define scan list.
:POINts?	Query number of channels in scan list.
:SCAN?	Query scan list.
:FCHannels <list>	Specify channels that cannot be closed.
:FCHannels?	Query channels that cannot be closed.
:INTerlockX	Specify interlock (X = [1] to 5).
:LIST[1]	Define List 1 for specified interlock.
:LIST[1]?	Query List 1 for specified interlock.
:LIST2	Define List 2 for specified interlock.
:LIST2?	Query List 2 for specified interlock.
:CONFigure	Configuration command path:
:BBMake <b>	Enable (1 or ON) or Disable (0 or OFF) Break-Before-Make switching.
:BBMake?	Query Break-Before-Make.
:SCHannel <b>	ENable (1 or ON) or Disable (0 or OFF) Single Channel.
:SCHannel?	Query Single Channel.

Table 11. ROUTe command summary (cont.)

Command	Description
[:ROUTe]	
:CONFigure	
:CPAirX <b>	Enable (1 or ON) or Disable (0 or OFF) Card Pair X (X = [1] to 5).
:CPAirX?	Query Card Pair X (X = [1] to 5).
:SLOTX	Path to configure SLOT X (X = [1] to 10):
:CTYPe <name>	Assign card ID number for specified slot.
:CTYPe?	Query card ID number for specified slot.
:POLE <NRf>	Select pole mode (1, 2 or 4) for specified slot.
:POLE?	Query pole mode for specified slot.
:STIMe <n>	Specify delay (0 to 99999.999 sec) for specified slot.
:STIMe?	Query delay for specified slot.
:MEMory	Path to program memory:
:SAVE	Path to save channel patterns:
[:RELays] M<num>	Save current channel pattern at specified memory location (1 to 500).
:LIST <list>, M<num>	Save defined channel pattern at specified memory location (1 to 500).
:RECall M<num>	Recall channel pattern from memory (1 to 500).

Table 12. Sense command summary

Command	Description
:SENSe[1]	
:TTL[1]	Command path to read internal input line.
:DATA?	Read internal digital input line.
:SENSeX	Specify slot; X=2 (slot 1) through 11 (slot 10).
:DATA?	Read digital input for the specified slot.

Table 13. :SOURce command summary

Command	Description
:SOURce	
:TTL[1]	Digital output line #1.
[:LEVel] <b>	Set line true (1 or ON) or false (0 or OFF)
[:LEVel]?	Query state of digital output line.
:TTL2	Digital output line #2.
[:LEVel] <b>	Set line true (1 or ON) or false (0 or OFF)
[:LEVel]?	Query state of digital output line.
:TTL3	Digital output line #3.
[:LEVel] <b>	Set line true (1 or ON) or false (0 or OFF)
[:LEVel]?	Query state of digital output line.
:TTL4	Digital output line #4.
[:LEVel] <b>	Set line true (1 or ON) or false (0 or OFF)
[:LEVel]?	Query state of digital output line.

Table 14. :STATus command summary

Command	Description
:STATus	
:OPERation	Path to control operation event registers:
[:EVENt]?	Query event register.
:ENABle <NRf>	Program the enable register.
:ENABle?	Query enable register.
:PTRansition <NRf>	Program the positive transition register.
:PTRansition?	Query positive transition register.
:NTRansition <NRf>	Program the negative transition register.
:NTRansition?	Query negative transition register.
:CONDition?	Query condition register.
:ARM	Path to control arm event registers:
[:EVENt]?	Query event register.
:ENABle <NRf>	Program the enable register.
:ENABle?	Query enable register.
:PTRansition <NRf>	Program the positive transition register.
:PTRansition?	Query positive transition register.
:NTRansition <NRf>	Program the negative transition register.
:NTRansition?	Query negative transition register.
:CONDition?	Query condition register.
:SEQuence	Path to control the sequence event registers:
[:EVENt]?	Query event register.
:ENABle <NRf>	Program the enable register.
:ENABle?	Query enable register.

Table 14. :STATus command summary (cont.)

Command	Description
:STATus	
:OPERation	
:ARM	
:SEQuence	
:PTRansition <NRf>	Program the positive transition register.
:PTRansition?	Query positive transition register.
:NTRansition <NRf>	Program the negative transition register.
:NTRansition?	Query negative transition register.
:CONDition?	Query condition register.
:TRIGger	Path to control trigger event registers:
[:EVENt]?	Query event register.
:ENABle <NRf>	Program the enable register.
:ENABle?	Query enable register.
:PTRansition <NRf>	Program the positive transition register.
:PTRansition?	Query positive transition register.
:NTRansition <NRf>	Program the negative transition register.
:NTRansition?	Query negative transition register.
:CONDition?	Query condition register.
:QUEStionable	Path to control questionable event registers:
[:EVENt]?	Query the event register.
:ENABle <NRf>	Program the enable register.
:ENABle?	Query the enable register.
:PTRansition <NRf>	Program the positive transition register.
:PTRansition?	Query the positive transition register.

Table 14. :STATus command summary (cont.)

Command	Description
:STATus	
:QUEStionable	
:NTRansition <NRf>	Program the negative transition register.
:NTRansition?	Query the negative transition register.
:CONDition?	Query the condition register.
:PRESet	Return status registers to default states.
:QUEue	Path to access error queue:
[:NEXT]?	Query most recent error message.
:ENABle <list>	Specify error and status messages for queue.
:ENABle?	Query enabled messages.
:DISable <list>	Specify messages not to be placed in queue.
:DISable?	Query disabled messages.

Table 15. :SYSTem command summary

Command	Description
:SYSTem	
:PRESet	Return to :SYST:PRES defaults.
:POSetup <name>	Select power-on setup: RST, PRESet, SAV0-SAV9.
:POSetup?	Query power-on setup.
:VERSion?	Query revision level of SCPI standard.
:ERRor?	Query Error Queue.

Table 16. Trigger command summary

Command	Description
:INITiate	Subsystem command path:
[:IMMediate]	Initiate one trigger cycle.
:CONTinuous <b>	Enable (1 or ON) or disable (0 or OFF) continuous initiation of trigger system.
:CONTinuous?	Query continuous initiation.
:ABORt	Reset trigger system.
:ARM[:SEQuence[1]]	Subsystem command path to configure arm layers:
[:LAYer[1]]	Path to program arm layer 1:
:IMMediate	Immediately go to Layer2.
:COUNt <n>	Program arm count (1 to 9999, or INF).
:COUNt?	Query arm count.
:SOURce <name>	Select control source: HOLD, IMMediate, MANual, BUS, TLINk, EXTernal.
:SOURce?	Query control source.
:SIGNal	Loop around control source.
:TCONfigure	Path to configure Triggers:
:DIRection <name>	Enable (SOURce) or disable (ACCeptor) Bypass:
:DIRection?	Query direction.
:ASYNchronous	Path to configure asynchronous Trigger Link:
:ILINe <NRf>	Select input line (1 to 6).
:ILINe?	Query input line.
:OLINe <NRf>	Select output line (1 to 6).
:OLINe?	Query output line.
:LAYer2	Path to program arm layer 2:
:IMMediate	Immediately go to Trigger Layer.
:COUNt <n>	Program scan count (1 to 9999 or INF).
:COUNt?	Query scan count.
:DELay <n>	Program delay (0 to 99999.999 sec)
:DELay?	Query delay.
:SOURce <name>	Select control source: HOLD, IMMediate, TIMer, MANual, BUS, TLINk, EXTernal.

Table 16. Trigger command summary (cont.)

Command	Description
:ARM[:SEQuence[1]]	
:LAYer2	
:SOURce?	Query control source.
:TIMer <n>	Set timer interval (0 to 99999.999 sec).
:TIMer?	Query timer.
:SIGNal	Loop around control source.
:TCONfigure	Path to configure Triggers:
:DIRection <name>	Enable (SOURce) or disable (ACCeptor) Bypass.
:DIRection?	Query direction.
:ASYNchronous	Path to configure asynchronous Trigger Link:
:ILINe <NRf>	Select input line (1 to 6).
:ILINe?	Query input line.
:OLINe <NRf>	Select output line (1 to 6).
:OLINe?	Query output line.
:TRIGger[:SEQuence[1]]	Path to program trigger layer:
:IMMediate	Immediately perform a scan step.
:COUNt <n>	Program measure count (1 to 9999, or INF).
:AUTO <b>	Enable (1 or ON) or disable (0 or OFF) auto-count (scan-list-length).
:AUTO?	Query auto-count.
:COUNt?	Query measure count.
:DELay <n>	Program delay (0 to 99999.999 sec).
:DELay?	Query delay.
:SOURce <name>	Select control source: HOLD, IMMediate, TIMer, MANual, BUS, TLINk, EXTernal.
:SOURce?	Query control source.
:TIMer <n>	Set timer interval (0 to 99999.999 sec).
:TIMer?	Request the programmed timer interval.
:SIGNal	Loop around control source.

Table 16. Trigger command summary (cont.)

Command	Description
:TRIGger[:SEQuence[1]]	
:TCONfigure	Path to configure Triggers:
:PROTocol <name>	Select protocol: ASYNchronous, SSYNchronous.
:PROTocol?	Query protocol.
:DIRection <name>	Enable (SOURce) or disable (ACCeptor) Bypass.
:DIRection?	Query direction.
:ASYNchronous	Path to configure asynchronous Trigger Link:
:ILINe <NRf>	Select input line (1 to 6).
:ILINe?	Query input line.
:OLINe <NRf>	Select output line (1 to 6).
:OLINe?	Query output line.
:SSYNchronous	Path to configure semi-synchronous Trigger Link:
:LINE <NRf>	Select trigger line (1 to 6).
:LINE?	Query trigger line.

Table 16. [illegible]

Command
[illegible]
[illegible]
[illegible]
[illegible]

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